2.—*On the Gulf Stream.* By A. G. FINDLAY.

IN the early part of 1853 I presented to the Society, in this room, some remarks on the Current Systems of the Ocean—at that time, as it still is, a comparatively neglected subject. In that paper I advocated the views that each great ocean has a circulatory system within itself, and that there was also a constant intercommunication and intercharge of the whole surface-water of the entire oceans.

Of this vast circulatory system, the Gulf Stream is the best known, as it is the most remarkable of these currents.

At that period it was fully believed that the Gulf Stream flowed in one mighty and majestic current of warm water from the surface to its bed, at great depths; and thus there was but little difficulty in believing that its tropically-heated waters could reach the shores of Europe with only a partial loss of the warmth they had acquired. But the first actual experiments, announced soon afterwards, dispelled at once all preconceived notions as to its vast magnitude.

The progress of deep-sea sounding, and obtaining the temperature at enormous depths, as well as determining the nature of the ocean-bed, although great, has not kept pace with the requirements of science.

The facts that have since been brought to light, have placed the subject in so much obscurity that it may be really said that we know very much less of the entire system, than was safely argued upon when only the surface-waters were considered. And I think that it would be impossible to generalise any system of ocean-physics which shall satisfactorily account for all observed phenomena, further than it is almost certain that there is some sort of circulation and interchange taking place in the lower strata, as can be sufficiently traced in the surface-waters of the ocean.

Now, as much vague surmise and loose assertion has of late been made respecting the possible effects of the Gulf Stream and its influence on the climate of this and adjacent countries, during the late period of unusually high mean temperature, I thought that it might be well to draw the attention of the Society to first principles, and to show what is actually and accurately known of this great current, as derived from later researches. I will, therefore, by the aid of the diagram, point out some of what may, as Mr. Bates has said, be termed "popular errors."

The waters of the North Atlantic circulate, as I have said before, around a central area—the Sargasso Sea; and the western branch of this circuit—that portion which issues from among the West India Islands, after recurving from the intertropical to the extratropical

regions—is well known as the Gulf Stream or the Florida Stream. Now, as this mighty current has been traced and measured, both in volume and velocity, along the coast of the United States as far as Nantucket, we can, from the known amount of each quantity at its entrance into the strait, easily measure its possible effects on distant regions.

The Gulf Stream, at its commencement is, confined between the coast of Florida and those of Cuba and the Bahama Banks, and no other water can reach it during this part of the course. The first section—that at its westernmost limit—was examined in 1858, between the Dry Tortugas and the entrance to the Havana, a distance of 98 miles, which showed that the water gradually deepened from the north side to the maximum depth of 770 fathoms, within 5 miles of the Cuban shore. The next section will be more suitable for my demonstration.

In 1866 it became necessary to lay an electric cable between the Florida Keys and the Havana, and the United States Coast Survey, under Mr. Hilgard, undertook the examination of the bottom. The line of soundings was carried from Sand Key to the Moro Castle of Havana, in a diagonal line across the main strength of the stream, where it first enters the Channel which gives its name—a distance of 82¼ miles. On the diagram this section is represented in its actual relative dimensions of breadth and depth; but as these are not very visible, an exaggerated section of five vertical to one horizontal is given. To this, and the next, particular attention is drawn, as they contain the clue to the real character of the Gulf Stream.

Starting from the northern side, the bottom falls away in terraces, nowhere abrupt, to a depth of 504 fathoms at the distance of 29½ miles, and to 687 fathoms at 34 miles, nearly half over. The maximum depth of 845 fathoms is found at 45½ miles from the north side; from this to the Cuban shore the bottom is hilly and precipitous, and at about 20¾ miles from the Moro the summit of a submarine mountain ridge is reached, which rises about 2400 feet above the bed of the strait, that is from within 380 to 320 fathoms of the surface. This mountain ridge has been traced for more than 12 miles parallel with the axis of the strait, and falling precipitously towards the south, deep water continuing close up to the south shore.

From the northern side the bottom is rocky with coral, to the depth of 300 fathoms; at depths beyond this, it is of that peculiar grey mud, or granular mud, sometimes with red patches, the ordinary type of the organic life of the ocean-bed.

The temperature of the water, varying according to the season,

from 80° or 84° on the surface, sinks to 60° on the summit of the ridge above mentioned, and is only 45° at the bottom—13° above the freezing-point of fresh water.

In the northern half of this section, above the terraces south of Florida Reefs, the water lies almost motionless, and it is only over the deep cañons of the southern half of the Gulf that the Gulf Stream flows to the eastward.

It is thus only 40 miles broad in its greatest strength. Its depth cannot exceed the summit of the submarine ridge, and it was found, on hauling in the sounding-line, that the upper moving stratum is scarcely more than *one-third* of the maximum depth. So that the actual sectional area of the Gulf Stream, at its highest temperature and greatest velocity, is not more than 5 to 8 square miles.

Such a well-determined fact shows how entirely fallacious were those speculations formed prior to its establishment. It will be no great sacrifice of preconceived opinion, to curtail the Gulf Stream of those widely extended and majestic features with which it was formerly endowed.

The data thus acquired as to its initial course is exactly borne out by further explorations beyond this.

Passing by the next section between the Sombrero Lighthouse and the Salt Key Bank, about 120 miles further to the eastward, where it is 45 miles wide (examined in April, 1859, by Commander Craven, U.S.N.), which showed that its maximum depth is only 600 fathoms, and the greatest depth still being on its southern side, and also the next, between the Carysfort Lighthouse and the Great Bahama Bank (examined by Commander Craven, in May, 1859), 63 miles wide, maximum depth about 500 fathoms, we come to the most important, because it is the crucial test of the magnitude and character of the Gulf Stream. Each of these sections is on the diagram before you, and they must speak for themselves.

The narrowest part of the Gulf Stream is also by very much the shallowest part of its course—a fact almost incredible, but that it rests on a solid basis. It was obtained by Commander Craven in 1855. The distance between Cape Florida and the Bemini Isles is 45 miles, and the maximum depth is only from 300 to 370 fathoms. The temperature of the water at the bed was only 49°; so that here again the warm water does not extend more than one-third or one-half the entire depth, demonstrating the cubical amount of warm water passing over this line to be nearly the same as that shown in the first section, from which this is distant about 250 miles.

Nothing is said here about the cold polar currents in a reverse direction, which have been traced in this its strongest and warmest

portion; but a very slight amount of reflection will raise a doubt as to whether such a bulk of water could reach our shores, and transport over so wide an area the influence of the tropical heat of the Gulf of Mexico.

A slight glance at its further progress will, I think, convert this doubt into a certainty with every one. It is confined between the Little Bahama Bank and the Florida Coast, and from this point to its entrance into the Gulf is about 330 miles.

Hitherto its course has been one undivided stream, lying over a very cold substratum, probably flowing in a reverse direction, and with cold counter currents appearing near its margin. To the northward it pursues its course, as is well known, generally parallel to the inequalities of the United States coast. But it here appears only as one of a series of parallel bands, the warmest of four belts, having one within it, and two (or more) to the east and south-east of it, which warm bands are separated by as many belts of colder water flowing in an opposite direction; and within or inshore is the very cold Arctic current, also flowing southwards. The warm belt of the true Gulf Stream is so pressed upon the coast that the exactly defined separation between its dark blue and tepid waters, and the lighter and much colder Arctic stream, has been termed the "Cold Wall,"—the division being so nearly perpendicular and well marked to great depths; and this characteristic is preserved as far as—and perhaps beyond—New York Harbour entrance. The outer edge is very vaguely defined, and in its northern portion it imperceptibly blends with the ordinary temperature of the ocean in the same latitudes. Beyond this it turns much more to the eastward, and having arrived at the meridian of the Nantucket Bank, about longitude 68° or 69°, its limits become still less defined, and when it reaches the meridian of 50°, or that of the Newfoundland Banks, its southern margin cannot be detected.

The inner or western edge is very sharply defined throughout its course along the coast of the United States. Why it is so pressed upon the cold Arctic current, with which it does not mix, has never, to my knowledge, been well accounted for.

I might here draw attention to the speculations of Mr. Leighton Jordan, which will very satisfactorily explain it, if his premises be accepted.

He argues that the *vis inertia* of the ocean will account for this, as for most other currents; and this is deserving of much attention. In few words, this pressure of the Stream upon the coast is owing to the diurnal rotation of the earth, which drives the land upon the

ocean waters, the latter being less subject to the axial motion of the earth. For our purpose this very definite feature of its left-hand margin being very much the warmest and strongest will bear out more fully the view I am now advocating, as it is that portion more subject to further disturbance, as shown presently.

The length of its course after leaving the Gulf of Florida to the tail of the Newfoundland Banks is about 3500 miles, and its breadth has increased from about 70 miles off Charleston, 120 miles off Cape Hatteras, at Nantucket, to perhaps 300 miles; and its mean annual velocity is 65·5 miles per day in the Strait of Florida, 56·0 miles off Charleston, 36·0 to 46·5 off Nantucket, and 28·0 miles south of the Newfoundland Banks. So that I have calculated that it would take from twenty to twenty-five days in the main strength of the current to reach Nantucket, or fifty days to arrive off the Newfoundland Banks. Its surface temperature has cooled down from 80° to 84°, to 58° in winter, and from 75° to 62° in summer; and, I think, it is evidently a physical impossibility that the volume of warm water which passes through the narrows of Cape Florida could ever make such an impression without some other addition to its strength. The whole bulk of water above 70° in the Florida Gulf would not make a film 100 feet thick at Nantucket or 50 feet at Newfoundland. I think it could be demonstrated that the existence of some of the outer warm bands above alluded to, is owing to a drift, which curves to the northward outside the Bahamas. But the observations recorded in the space north of the Bahamas show no evidence of such a drift, which it is difficult to believe does not exist. Having reached the point south of Newfoundland, a new phase is arrived at. It here encounters the Arctic Current coming down the coast of Labrador throughout the year, and during the spring and summer months transporting the deeply-floating icebergs far into its northern edge, and this northern or left-hand edge has been before shown to be its strongest and most well-marked portion. The struggle between the Arctic and Tropical currents is here so strongly marked that the interlacing of the warm and cold waters, as shown by the thermometer, has been compared to the clasped fingers of the hands; and the veins of each of these distinctly marked ocean-waters are so well defined that a few miles or even yards is sufficient to carry a ship out of or into a tropical influence.

One feature of this down-bearing current is very distinctly marked, and deserves especial attention. On the eastern side of the Grand Bank it is so powerful that according to the surface isotherms it penetrates from 150 to 200 miles southward of its

general limit, and therefore entirely intersects the surface-waters of the easterly stream, for that breadth, which, as before stated, is the most important part of its course.

I contend, therefore, that by the time the Gulf Stream has reached this limit its original character is so thinned out and expanded, and its specific character is so destroyed from this cause, and from the neutralising effects of this Labrador current, that it can be no longer recognised beyond this cold-water gulf, which cuts off, as it were, its further progress, and which, it is manifest, it can neither bridge over nor pass under. The well known north-easterly drift which reaches the shores of Northern Europe, which is *warmer* at 300 miles north-east of the Newfoundland Banks than the Gulf Stream south of them, must be produced by other causes, and has a distinct origin: it is therefore time that it had a distinct designation.

But the evidences of the existence of the Gulf Stream pass beyond this. The Gulf weed it has drifted, the cocoa-nuts and tropical produce which are thrown upon the coast of Iceland and Norway, the same evidences of its transporting power which are at times found on the south coast of Iceland, and more abundantly in the space south of Cape Farewell, and the drifted mahogany-log which made the Danish Governor's dining-table, on the west coast of Greenland, were carried by other powers than that of the Gulf Stream.

It would take, from the data I have reckoned, 150 days to carry any object from the Banks of Newfoundland to our coasts, or 200 days from the West Indies, and this fact also, combined with what has been said before about the actual bulk of the Gulf Stream, will demonstrate that it is impossible such effects can be attributed to it, because in addition, it is continuous with that stream which flows southward down the coast of Portugal, the eastern branch of the circulation of the North Atlantic surface-waters.

How, then, can the phenomenon of our warm climate be accounted for? The reason is most simple and obvious. The great belt of anti-trade or passage winds which surround the globe northward of the Tropics, passing to the north-eastward, or from some point to the southward of west, pass over the entire area of the North Atlantic, and drift the whole surface of that ocean towards the shores of Northern Europe, and into the Arctic basin, infusing into high latitudes the temperature and moisture of much lower parallels; and which alone would be sufficient to account for all changes of climate by their variations, without any reference whatever to the Gulf Stream.

A few words as to the ocean-bed and its inhabitants. The facts cited by Lieutenant Chimmo, combined with those of other observers in most parts of the ocean, demonstrate, as I believe, one important fact, that the whole of the ocean waters are in course of interchange, and that, like the atmosphere, there is a perpetual movement from the surface to the bottom.

If otherwise, and the lower beds are quiescent, how do those minute creatures, almost deprived of motion, exist? They would soon exhaust all their requirements from the waters within their reach, if fresh supplies were not brought to them by this circulatory system.

The same organisms are found all over the areas experimented on, whether under the Arctic circle or under the heated Tropics, and the ascertained temperatures are nearly the same in all cases, proving that there is a similar water-climate throughout.

Another evidence of this circulation is the universality of the composition and characteristics of ocean water. If it were not so, each region would possess a different fauna, having a different description of medium to exist in. It is the same from the surface to the bottom. This was demonstrated by the star-fish brought up *alive* between Greenland and Iceland, from the depth of 1260 fathoms (1¼ mile). If these animals had been brought through water of different constituent character, they would have died during the hour it took to haul them in.

Although what has been thus briefly stated may be antagonistic to the generally received opinion, I hold that it cannot be altogether contradicted, and, instead of offering any further explanation of known phenomena, I recommend the subject to the zeal of future observers.

Our present knowledge is almost a blank, and the matter deserves every consideration.

The CHAIRMAN, in inviting a discussion on the Papers, remarked that there were two distinct matters for consideration. One was the hydrography of the Gulf Stream, and the other the general question of submarine geography. Both subjects were of great interest, and he hoped they would both receive elucidation that evening. He was afraid that many of the Fellows, like himself, had so grown up in the belief that the temperature of our country was affected by the Gulf Stream that they would find a difficulty in doubting it. Nevertheless, Mr. Findlay's arguments tended to shake that belief. Still, he should like to hear the cause of the peculiarly mild temperature of the West of England explained. If it were due merely to currents of wind, he would have thought the same mildness might have been perceptible far more inland than it was. He hoped that as Professor Huxley, one of the first authorities in England on all questions of submarine animal life, was present, he would be kind enough to state his views with reference to these interesting forms of animal life, some of which had been brought up from a depth of 2700 fathoms.

Submarine geography was not merely interesting in that point of view, it was also a practical question. Geographers ought to obtain as accurate a knowledge of the surface of the globe under the sea as they possessed of the surface of the globe above the sea. The deep-sea soundings that were now being carried on in different parts of the globe had the object of ultimately arriving at such a knowledge. It was not until we possessed this knowledge that we should be able to traverse the oceans with telegraph cables, for there was no reason why we should not lay down submarine lines in all directions with the same facility that we now employed aërial telegraphs. As a contribution to this, he regarded Lieutenant Chimmo's paper as meriting great consideration.

Captain SHERARD OSBORN, R.N., said Lieutenant Chimmo's paper was a most valuable addition to our knowledge. Previous to his soundings off the southern extremity of the Newfoundland Bank the Gulf Stream in that quarter was reported to be unfathomable. Lieutenant Chimmo had sounded to the bottom on every occasion he attempted but one, and then probably the bight of his line was carried away by currents. Moreover, by careful observation, he had disposed of a very alarming feature which was said to exist in mid-ocean—the Milne Bank, named after the gallant officer who was said to have discovered it. It was a pleasant thing to be assured that no such bank existed, and for this they were indebted to Lieutenant Chimmo. He had, moreover, confirmed our previous knowledge respecting the level of the ocean bed between the coasts of Europe and those of America. We might take the mean depth to be about 2000 fathoms across the North Atlantic Ocean. And he had disposed of the theory that the Gulf Stream had an enormous scooping effect, wearing a deep furrow in the sea-bottom. As Mr. Findlay had shown, its depth might be limited, as far as the warm water indicated. But he himself did not see why the stream should be limited to warm water—why it should not combine both hot and cold. He still believed in the existence of the Gulf Stream, from the enormous quantity of wood and drift that he had noticed far away to the north: and he believed that the Gulf Stream did ameliorate our climate very considerably—that the mildness of our climate was owing not merely to the effects of warm air, but to the effects of water of a high temperature as well. There were very few sailors acquainted with the sea between the Azores and the Land's End who had not noticed tropical species of fish accompany drift-timber there. Wherever we found the dolphin and other fishes of warm seas, we might be sure that the temperature of the water was pretty much the same that it was in the tropics. Then there were many other streams of a similar character in different parts of the globe. There was that remarkable stream on the east coast of Africa which flowed from Cape Guardafui for 2000 miles, almost into the harbour of Bombay. That had recently been explored by an officer in our service, and he had obtained soundings throughout its whole length. There was a similar stream, called the Black Stream, between China and Japan, which was just as marked at the edge as the Gulf Stream. Beyond this there was little or nothing known of it: he did not believe it had been sounded, or that its limits had been marked. All these streams ran parallel to each other, nearly from south-west to north-east; they formed three great oceanic streams, as it were, which flowed through the wastes of ocean with outlines as marked as the Mississippi or the Orinoco. Here was an immense field laid open to the investigation of the hydrographer; and he only hoped that members of his profession, while the sword was laid aside, would, encouraged by our Society, throw their enterprise and intelligence into so promising a field of discovery and usefulness.

Professor HUXLEY said no naturalist who had looked broadly at his subject could fail to be greatly interested in physical geography; no man could have a conception of the bearing of a great many most important biological

facts who had not paid very considerable attention to this department of science, and to all those great features of oceans and rivers which were either the causes or the effects of the phenomena of physical geography. He proposed, therefore, to make remarks on the two subjects submitted to their consideration that evening: the Life of the Sea-bottom, and the Gulf Stream. With regard to the deep-sea soundings which Lieutenant Chimmo had described, speaking with every respect for the zeal and high intelligence which that gentleman had displayed in his observations, and knowing practically how difficult it was to make such observations while at sea, he still might be permitted to remark that they made no substantial addition to what had already been established by a considerable number of observers with regard to the character of the Atlantic sea-bottom. In some respects he ventured to think—having been favoured by the Hydrographer to the Admiralty with the particular soundings that Lieutenant Chimmo had brought home—that he had not quite clearly interpreted the facts. There could be no doubt that animal remains were contained in a very large proportion of the *Globigerinæ* shells. By proper methods of treatment, by dissolving them in acids, you may get out the soft bodies. Not only so, but Professor Frankland, to whom he had submitted portions of such soundings, had determined, by the processes of organic analysis, the existence of more than 1½ per cent. of organic matter in these soundings; which 1½ per cent. of organic matter could be clearly identified by the microscope in two shapes: in part as *Globigerina* shells, in part as a confused network of simple organisms, distinct from the *Globigerinæ* — one of the most remarkable of simple organisms, to which he had given the name of *Bathybius*. That simple organism—one of the simplest forms of animal life—we now know covered the whole area of the North Atlantic in all the regions that had yet been surveyed. The very admirable soundings in the Indian Ocean which had been made by Captain Shortland, to which Captain Sherard Osborn referred, had enabled him to extend his knowledge of that organism. From the Arabian Gulf, at a depth of 2800 fathoms, along the whole of the east coast of Africa, round the Cape of Good Hope, and along the west coast until it joined the North Atlantic again, he could trace throughout the whole extent, at these prodigious depths, that that sea-bottom was covered with a network of organic matter. There could be no sort of doubt that living animals exist at the bottom of the deepest seas yet explored. How they lived there, how they acquired their store of food, was one of the most curious questions of organic chemistry; one which we could not solve at present. But it was the fact that there were two distinct constituents in this Atlantic mud: one of them like the organisms which he had described and the *Globigerinæ* living on the sea-bottom, and the other silicious remains of organisms living near the surface, and which only reached the bottom after they died, for their skeletons had sunk down through the great depth of sea-water and mixed with the living creatures at the bottom. He looked upon those two results as now definitely acquired to science. He might remark, perhaps, in reference to something which was let fall by Captain Osborn, that, as far as he had been able to examine the deep-sea soundings from the Arabian Gulf, the character of the bottom was, in the main, very similar to that of the great Atlantic plateau. Over most parts of it the sticky, adhesive *Globigerina* mud exists in large proportion, and in certain parts *Globigerinæ* are replaced by an excessively fine and attenuated sand. But in all the specimens which had been brought up by Lieutenant Chimmo there was an entire absence of everything but the very finest and softest calcareous or silicious matter. With regard to the hydrographic question of the extent of the Gulf Stream, he had listened with very great attention to the facts and argument which had been brought forward by Mr. Findlay, and he must confess he had arrived at two results unfavourable to the purport of the paper. The first was that he did not find

in the statements brought forward any facts not to be met with in the works of Maury; and still more particularly in that excellent essay upon the Gulf Stream which was published a year or two ago by Kohl, and to which he would recommend every one who took a particular interest in the subject for a perfect plethora of facts connected with the phenomena of the Gulf Stream. The second conclusion was, that the arguments which had been brought forward did not seem to justify the important conclusion arrived at. Indeed, he thought a considerable amount of fallacy lurked in those arguments. Mr. Findlay drew attention to the very small extent of the Gulf Stream between the peninsula of Florida and Cuba; and he asked the question, how was it credible that so small a volume of water as this should give rise to the great mass of warm water which was found taking a north-eastern and easterly course in the northern part of the Atlantic? Now, if the velocity of the water which passed through the Straits of Florida were the same as the velocity of the water in the region of Newfoundland, that query would have considerable force. But it seemed to him to fail, unless we took into account the fact that the velocity of the water passing through the Straits of Florida was three or four times greater than that of the stream in the North Atlantic. These facts regarding the Gulf Stream had been well established by the careful observations and surveys of the American Navy; and he must say it was a disgrace to this country that, with our vast naval resources, we could not produce anything to compare with these great American surveys. But, leaving that aside as a mere incident in the question, he would say that the consideration of relative velocity, is one of great importance in view of the difficulties put before us. Another argument which he would bring against Mr. Findlay's conclusions was based upon the very admirable map of the Gulf Stream published last year by the Hydrographer of the Admiralty. Every one who knew that map would say it was a document of extreme value, a first-rate authority; and in that map the currents continuous with those of the Gulf Stream were traceable, with diminished velocity, to the northern points of the coast of Scotland. He did not think any one who looked at that map, and traced out the gradual diminution of that stream, could have any doubt that he was dealing with a phenomenon that had one and the same cause. Another argument quoted by Mr. Findlay from another author was so singularly at variance with what we knew of ordinary physical laws, and with what was very well known with regard to the Gulf Stream in particular, that it could not stand its ground for a moment. It had been suggested that this easterly trend of the Gulf Stream was due to the Earth in the northern part of America shunting it on as it turned round.

Mr. FINDLAY: It was Mr. Leighton Jordan's argument.

Professor HUXLEY: The argument of Mr. Leighton Jordan appeared to be that the water, not partaking fully of the movement of the Earth, was, so to speak, shunted on to the eastward by the action of the eastern side of North America. In any case, an explanation of that kind could not possibly apply. We all knew, as a matter of physics, that the water at the equator partook of the motion of the Earth at the equator. It consequently had a greater velocity from west to east than the surface of the Earth in more northern latitudes. We also knew, in accordance with the ordinary laws of physics, that if that mass of water were transferred northwards, it would, for a considerable time, keep its primitive velocity. The consequence would be that, as it travelled from west to east faster than the Earth was travelling in a corresponding latitude, it would trend away to the eastward; so that, so far from the land forcing the water to the eastward, it was the water that trended to the eastward, leaving the Earth behind it.

Mr. FINDLAY thought his arguments had been misunderstood. He had carefully calculated the velocity of the Gulf Stream at its initial point, and the

amount of water carried forward day by day. The velocity was exceedingly well known; its annual mean and its monthly mean were also very well known. The stream took 25 days to reach Nantucket, 50 days to reach the Newfoundland Bank, and 200 days to reach the western coast of Europe. From its known sectional area between Florida and Cuba, he contended it was impossible such a stream could spread over the whole of western Europe up to Iceland, as far as the northern coast of Norway and Spitzbergen, and to other places where there was a comparatively mild climate. He repeated, such a body of water passing from the Gulf could not produce those effects on the climate of the whole of western Europe without being aided by some other causes. Then there was the fact that the warmest point of the Gulf Stream was on its western edge: the warmest water being pressed upon the American coast, along which the polar current was running south. He wanted to know why that was? why the warmth should not be diffused more to the eastward? It was only a suggestion of Mr. Leighton Jordan that the axial rotation of the Earth might account for the phenomenon in some degree. But, apart from that, he would contend that that small body of water would never cover the whole of the west coast of Europe; it was the great winds which blew from the south-west in that part of the Atlantic that produced a drift towards the coasts of Europe. Moreover, there was the drift of water round the Bahama Bank, which joined the Gulf Stream; the Gulf Stream, in fact, could form only a fractional portion of the circulation.

The CHAIRMAN, in closing the discussion, said the great point was to bring men of science and practice together, for truth was elicited by the efforts of the two. He was much indebted to Professor Huxley for giving him the chance of still indulging in those ideas that he had always entertained with regard to the effect of the Gulf Stream upon our climate. He must say he did not think that Mr. Findlay had absolutely dissipated that belief.

The following paper, announced for reading, was taken as read:—

3.—*Journey to the Confluence of the Mantaro and Apurimac.* By ANTONIO RAIMONDI, Hon. Corresponding Member of the Royal Geographical Society.

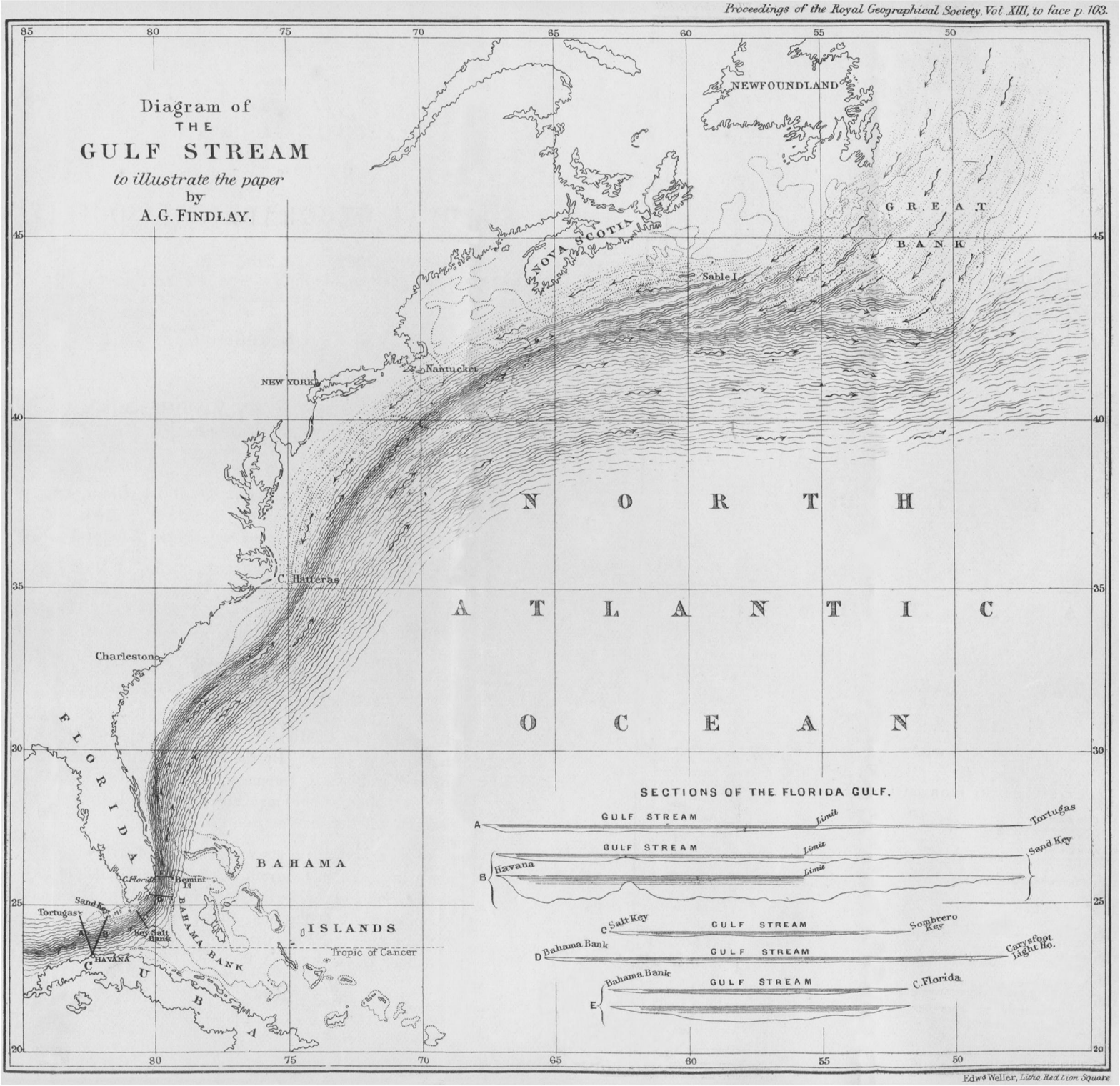
This will be printed entire in the 'Journal,' vol. xxxviii.

Seventh Meeting, 22nd February, 1869.

MAJOR-GENERAL SIR ANDREW SCOTT WAUGH, R.E., F.R.S., VICE-PRESIDENT, in the Chair.

PRESENTATIONS.—*Charles H. Stanton, Esq.; Lieut. Henry Trotter*, R.E.

ACCESSIONS TO THE LIBRARY from 8TH to 22ND FEBRUARY, 1869:—'A Visit to the Southern Galas (East Africa).' By T. Wakefield. 1866. Donor, the author. 'Emigration to Venezuelan Guyana.' By L. Clark. 1868. Donor, the author. 'A History of the Abyssinian Expedition.' By Clements R. Markham. 1869. Purchased. 'Anales de la Universidad de Chile.' 'Historia jeneral de la Republica de Chile. 'Bibliografia de la Literatura Chilena.' 'El Terreno



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